Analyses of Emission Datasets Used in Global and Regional Chemical Transport Models

Lin, J.-T.[1], D. Wuebbles[1], K. Patten[1], A. Williams[2], H.-C. Huang[2], M. Caughey[2] and Z.-N. Tao[2]
[1] Department of Atmospheric Sciences, University of Illinois at Urbana-Champaign, IL; [2] Illinois State Water Survey, IL

Abstract

Global and regional chemical transport models (CTMs) are being used to study the air quality problem over different spatial scales from global to regional. We are examining the coupling between such models to investigate the interaction between localized emissions and pollutant transport for the studies of the relationships between climate change and local air quality. In our project, the Model for OZone And Related chemical Tracers version 2 (MOZART2) and the Air Quality Model (AQM) are being used to simulate the impacts of global climate and emission changes on the U.S. air quality. MOZART2 is used to provide boundary conditions for the regional model studies and thus provides the effects of long-range transport of pollutants into the regional scale studies. These models use greatly different emission inputs, the Emission Database for Global Atmospheric Research (EDGAR, updated version) in MOZART2 and the Environmental Protection Agency (EPA) National Emission Inventory-99 (NEI99) in AQM. Here a series of calculations will be presented, in which the effects of both emission datasets are compared in the global model. Two model results (MOZART2 with EDGAR and MOZART2 with NEI99) are compared. In the model analyses, the focus species are ozone, CO, NOx and non methane VOCs; the focus period is summer; while the focus locations are New York (northeast), Chicago (Midwest), Los Angeles (California), Seattle (Northwest) and a background site (46.42N,-105E).

Comparisons between EDGAR and NEI99 emissions datasets

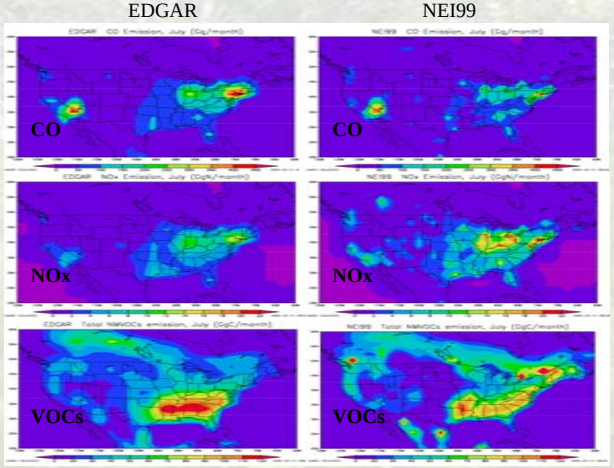

Figure 1. Emissions of CO, NOx and non-methane VOCs in EDGAR and NEI99 emissions datasets in July 1995.

Species	EDGAR		NEI99	
	Global	USA only	Global	USA only
CO	1443.47	186.28	1428.42	176.81
NOx	37.45	7.43	38.52	8.5
Acetone	60.59	1.61	59.52	0.85
CH2O	6.97	0.54	6.99	0.56
C2H4	18.83	0.89	18.74	0.86
C2H6	11.21	0.46	11.21	0.5
C3H6	8.98	0.35	9.04	0.41
C3H8	13.67	0.54	15.94	1.38
CH3OH	312.02	13.61	312.02	13.61
Isoprene	501.86	22.95	492.47	16.33
NMV	74.77	6.36	86.41	14.78
Terpenes	129.06	8.52	126.81	6.74

Table 1. Annual emissions budgets in global and regional datasets (EDGAR vs. NEI99). In the 'Global' column NEI99 is only for summertime U.S., Canada and Mexico, and data in other seasons/areas are from EDGAR. The units are Tg/yr (CO), TgN/yr (NOx) and TgC/yr (VOCs).

Comparisons of MOZART outputs with EDGAR and NEI99 emissions datasets

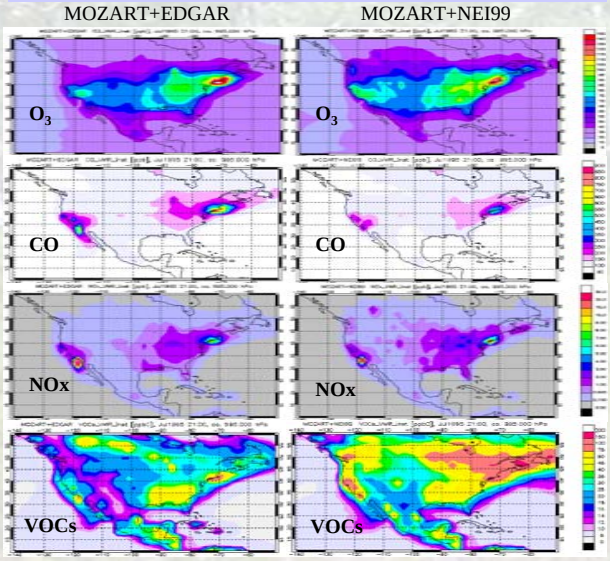

Figure 2. Monthly mean concentrations of O_3, CO, NOx and VOCs in the outputs of MOZART with EDGAR and NEI99 emissions at 2100UTM, July 1995 at the surface level.

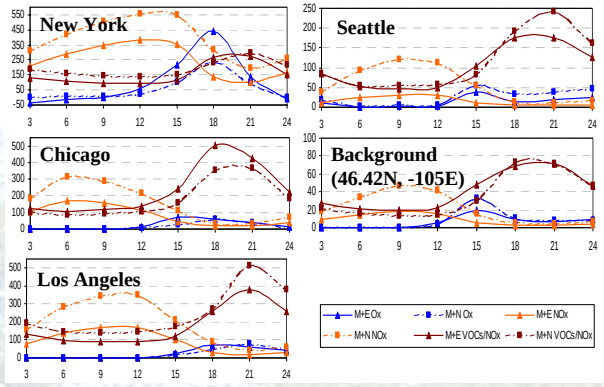

Figure 3. Monthly mean diurnal cycles of Ox net production rate (10^6/cm^3/s), NOx Concentrations (10^{-1} ppb) and VOCs/NOx ratio in July 1995 at the surface level. Scale factors of VOCs/NOx ratio are 30 (New York, Chicago and Los Angeles); 5 (Seattle) and 1 (Background). M+E: MOZART with EDGAR; M+N: MOZART with NEI99.

Conclusions

- EDGAR in general has much higher CO and much lower NOx emissions, and, except in the southeastern U.S.and the Great Plains, lower non methane VOCs emissions compared to NEI99.
- Generally, the simulation of MOZART using EDGAR emissions (MOZART+EDGAR) has lower ozone concentration compared to using NEI99 emissions except around New York area and off the west coast. EDGAR produces higher CO and lower NOx and VOCs concentrations.
- In New York area, ozone production appears to be VOCs limited and MOZART+EDGAR has much lower NOx and VOCs concentrations. The much higher ozone concentration is probably due to much higher CO concentration. Ozone concentrations in both simulations exceed EPA 1-hour standard (120 ppb) roughly from late morning to late afternoon. Peak ozone net production rate is in the early afternoon (1800UTM).
- In Chicago, both simulations have similar ozone concentrations; while MOZART+EDGAR has lower NOx and VOCs concentrations, and higher CO concentration.
- In Los Angeles, MOZART+EDGAR has lower ozone concentration, due to much lower NOx and VOCs concentrations and higher CO concentration.
- In Seattle, MOZART+EDGAR has lower ozone concentration, since it has lower NOx and much lower VOCs concentrations and similar CO concentration.
- In the Montana region (46.42N,-105E), MOZART+EDGAR has lower ozone concentration, due to lower NOx and VOCs concentrations. Peak ozone net production rate as well as the associated difference between two simulations is in the early morning (1500UTM).